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**Patentanmeldung Nr. | Patent application No. | Demande de brevet n°**

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Filter medium for a vacuum cleaner bag

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# FILTER MEDIUM FOR A VACUUM CLEANER BAG

## Description

The invention is directed to a filter medium, in particular, for a vacuum cleaner bag, comprising a filter structure.

Nowadays, many vacuum cleaner bags comprise filter structures that are composites of nonwoven materials instead of conventional filter papers, these composite materials showing a high filtration efficiency and capacity.

EP 0 960 645 discloses such a prior art vacuum cleaner bag. This prior art construction is made of three layers, namely, in the direction of the airflow a bulky meltblown, a filtration grade meltblown fleece and a spunbond or spunlace layer. The upstream bulky meltblown layer which will be located at the inner side of the bag serves to remove large amounts of dust particles, to hold the dust in its structure and to protect the filtration grade meltblown layer from larger dust particles.

The prior art filter structures have a high filtration efficiency. However, it turned out in practice that elongated particles or objects with small diameters such as hairs (having a diameter of about 70.2 ± 12.3μm) tend to penetrate the filter. This penetration mainly occurs in the region where the airflow of the vacuum cleaner meets the wall of the filter bag. The elongated objects act like spears and pierce the filter structure. Although these elongated objects usually do not exit the filter bag, many of them stick out of the outermost layer of the bag. Therefore, these objects are visible from the outside which is aesthetically disturbing.

In view of this, it is the problem underlying the invention to provide a filter medium, in particular, for a vacuum cleaner bag that has a better retention regarding elongated particles and objects.

This problem is solved by a filter medium in accordance with claim 1. Accordingly, the invention provides a filter medium, in particular, for a vacuum cleaner bag, comprising a filter structure wherein a surface or an interface of the filter struc-

ture is provided with a filter paper layer having a smaller surface area than the filter structure.

The filter structure may be constituted of a single filter layer or may comprise several adjacent layers. In a composite structure, one of the layers, for example, may function as a coarse filter whereas another layer may be responsible for filtering and holding fine dust. Of course, other multi-layer structures are also possible.

The filter paper layer can be provided at a surface of the filter structure. Alternatively, in a multi-layer structure, the filter paper layer can also be provided at an interface between two layers, i.e. at a surface of one of the layers of the structure.

The filter paper layer is to be provided at a region of the filter medium such that, in operation, an airflow to be filtered or its main or most intense part meets the filter medium, in other words, at a region that is exposed directly to the airflow to be filtered. As already pointed out before, the filter medium can be provided with the filter paper layer such that the airflow meets the filter paper layer first or, alternatively, such that the airflow is passed through one or several other layers before meeting the filter paper layer.

However, if the filter medium comprises more than one layer, the specific filtration capabilities of the different layers can exploited in an improved way if the filter paper layer is not provided between these layers but at one of the surfaces of the composite.

The filter paper layer has two functions. On the one hand, it reinforces the filter medium thereby reducing the amount of elongated particles passing through the filter medium in the region of the filter paper layer. On the other hand, due to the additional paper layer in a specific region, the air permeability of the filter medium in this region is reduced. This means that an airflow meeting the filter medium at this part of its surface is partly deviated. As a consequence, the airflow in this region is reduced and particles entrained with the airflow meet the filter with re-

duced velocity. In view of this, the filter has a much better retention regarding elongated particles and objects.

The filter paper layer has a smaller surface area than the filter structure in order to maintain a high air permeability of the overall filter medium. If the whole surface of the filter structure were provided with the filter paper layer, the air permeability of the filter medium would be reduced resulting in a poorer filtration efficiency. The filter paper layer can have any shape such as a curvilinear or a polygonal shape.

Preferably, the filter paper layer can be bonded to the filter structure. This ensures that the position of the filter paper layer remains constant during use of the filter medium.

According to a preferred embodiment, the filter paper layer can be bonded using an adhesive such as a hotmelt, a cold glue, a dry bond adhesive and/or a thermoplastic polymer.

Advantageously, the filter paper can be bonded to the filter structure at discrete regions. In other words, not the entire surface of the filter paper layer is bonded to the filter structure. An adhesive can be applied to the filter paper layer only at discrete regions, for example, in form of dots. In this way, the reduction of the air permeability due to bonded areas is kept small.

Preferably, the filter structure can comprise a nonwoven layer. The term "nonwoven" is to be understood as excluding papers in accordance with the definition of the European Disposables and Nonwoven Association (EDANA). The nonwoven layer can be a dry-laid or a wet-laid nonwoven layer. Preferably, it can be an airlaid, a spunbond or spunlace or a meltblown layer. Alternatively or additionally, the filter structure can comprise a high dust holding capacity paper as disclosed in EP 0 960 645. The specific types of layers can be chosen so as to provide the desired filtration capabilities such as filtration efficiency and dust holding capacity.

Preferably, the filter structure can comprise at least two nonwoven layers.

In an advantageous embodiment of the above-described filter media, the filter structure can comprise a spunbond/meltblown/spunbond structure. Preferably, the filter structure can comprise successively a spunbond, an airlaid, a spunbond, a meltblown, and a spunbond layer. In this way, a highly advantageous five-layer composite with excellent filtration properties is obtained. Here, the term "successively" only specifies the order of the different layers within the filter structure. Additional layers between successive layers are possible and not excluded by this formulation; in particular, the filter paper layer can be provided at an interface between successive layers.

Preferably, the spunbond and/or the meltblown layers can comprise polypropylene (PP) fibers. The airlaid layer can comprise bi-component fibers (PP/PE) or fluff pulp fibers or a blend thereof.

According to a preferred embodiment of all previously described filter media, the filter paper layer can have an air permeability of at least about 250 $l/m^2/s$, preferably of at least about 500 $l/m^2/s$, most preferred of at least about 600 $l/m^2/s$.

As already described above, it is one object of the filter paper layer to deviate the main part of the airflow meeting the filter medium. The lower the air permeability of the filter paper layer, the more air is deviated. However, if the air permeability is too low, almost the whole airflow is deviated such that most of the airflow meets the filter medium at regions surrounding the region of the filter paper layer which results in a penetration of the elongated objects around the filter paper layer. The above lower limits for the air permeability of the filter paper layer provide excellent results regarding the retention of elongated particles.

Advantageously, the filter paper layer of the previously described filter media can have a basis weight of between 20 and 100 $g/m^2$, more preferred of between 35 and 50 $g/m^2$. These limits for the basis weight of the filter paper layer insure a highly advantageous filter quality with an improved retention of elongated particles.

The invention also provides a vacuum cleaner bag comprising one of the previously described filter media.

Preferably, the filter paper layer can be provided at a region of a surface of the filter structure such that, in operation, the region is exposed directly to an airflow entering the bag. This means that an airflow after having entered the bag is to meet the filter medium at this region.

According to an advantageous embodiment, the vacuum cleaner bag can comprise two portions of filter medium wherein both portions are bonded together at an outer edge and wherein the first portion comprises an air inlet and the second portion comprises the filter paper layer at a region opposite to the air inlet. Thus, in operation, after entering the vacuum cleaner bag through the inlet, the airflow directly (i.e. without deviations and reflections) meets the region of the filter medium that is located opposite to the inlet where the filter paper layer is provided.

The bonding of the portions of filter medium can be achieved with the help of standard methods such as ultrasonic bonding or using an adhesive, for example. The portions of filter medium can be individual filter media (for example, individual multi-layer composites) that are bonded together. Alternatively, the portions can be part of a single filter medium that is folded and, then, the edges are bonded together yielding a closed volume. For example, a rectangular filter medium can be folded such that two portions of the filter medium (again having a rectangular shape) are lying on top of each other. A bag is obtained by bonding the two portions.

Preferably, the filter paper layer can be provided at the inner surface or the outer surface of the bag. In other words, the filter paper layer advantageously is not situated at interfaces within the filter medium.

Further features and advantages of the invention are described in the following with reference to the figures.

Fig. 1A shows a cross-section of an example of a filter medium in accordance with the present invention;

Fig. 1B shows a cross-section of another example of a filter structure according to the present invention;

Fig. 2A shows a front view of a vacuum cleaner bag comprising a filter medium according to the present invention; and

Fig. 2B shows a cross-sectional view of a vacuum cleaner bag comprising a filter medium according to the present invention.

Fig. 1A shows a cross-section of a five-layer filter medium that can be used for a vacuum cleaner bag. The filter structure comprises successively a spunbond layer 1, an airlaid layer 2, a spunbond layer 3, a meltblown layer 4, and another spunbond layer 5. The direction of the airflow in operation of the filter medium is indicated by arrows. Upstream the first spunbond layer 1 of the filter medium, a filter paper layer 6 is provided. Thus, this filter paper layer 6 is provided at one of the surfaces of the five-layer composite of the filter medium. If this filter medium were used in a vacuum cleaner bag, this surface would be in fact the inner surface of the bag. As can be seen in the figure, the filter paper layer 6 has a smaller surface area than the filter structure.

An alternative example of a filter medium according to the present invention is shown in Fig. 1B. In this example, the filter medium comprises a similar five-layer composite as in Fig. 1A, in particular, also comprising a spunbond/meltblown/spunbond structure formed by layers 1, 4 and 5. In the example of Fig. 1B, the filter paper layer 6 is provided at the other surface of the five-layer composite than in Figure5 which would be the outer surface of the vacuum cleaner bag as can be seen from the direction of the arrows.

The five-layer composite structure shown in Fig. 1A and Fig. 1B is realized in the commercially available CAPAFIL 50 (standard) vacuum cleaner bag. The shape of such a CAPAFIL 50 bag is illustrated in Fig. 2A and 2B. In the CAPAFIL 50

bag, the inner spunbond layer 1 has a basis weight of 17g, the airlaid layer 2 a basis weight of 50g, the spunbond layer 3 a basis weight of 17g, the meltblown layer 4 a basis weight of 24g and the outer spunbond layer 5 a basis weight of 25g.

Such a vacuum cleaner bag was used to test the effects of the present invention. The results of these tests are shown in Table I. In these tests, a CAPAFIL 50 (290 x 260mm) vacuum cleaner bag was tested in a MIELE vacuum cleaner S511 electronic. The test material was a mixture of 50 g of human hairs, 50 g of rice (dry), and 150 g of standard dust (mineral dust according to IEC 312). The test material was vacuumed and, then, the vacuum cleaner was operated for 15 minutes. After that, the number of hairs sticking out of the bag were counted. In the case of longer operation times (such as in the last two columns of Table I), the vacuum cleaner was operated several times for 15 minutes with breaks between the intervals.

In a first test, the CAPAFIL 50 vacuum cleaner bag was used without additional filter paper layer. The result is shown in the first column of Table I.

Then, quadratic filter paper layers with dimensions of 150 x 150mm with different characteristics were provided. They were positioned 45mm from the lower edge of the bag at the center of the portion of the filter medium opposite to the portion comprising the air inlet. The filter paper layer was bonded to the five-layer composite on the inside and the outside of the bag, respectively. The following filter paper types were used.

<u>Standard filter paper</u>

As standard filter paper, VACFILT 50 MRL produced by MB Papeles Especiales, S.A. was used. According to the manufacturer's characteristics sheet, this paper has a basis weight of 50 g/m$^2$ (DIN EN ISO 536) and an air permeability of 315 l/m$^2$/s (DIN EN ISO 9237 at 2mbar). The test results for this paper being provided at the inside of the bag and at the outside is given in columns 2 and 3 of Table I.

VE 45 MU paper

Another type of paper was VE 45 MU paper produced by FiberMark Gessner. According to the manufacturers technical data sheet, this paper has a basis weight of 45 g/m$^2$ (ISO 536) and an air permeability of 400 l/m$^2$/s (EN ISO 9237 at 200 Pa). The corresponding test results with this paper being provided at the inside of the bag and at the outside is shown in columns 4 and 5 of Table I.

VACFILT 35/7 MB

Another test paper was VACFILT 35/7 WHITE produced by MB Papeles Especiales, S.A. According to the manufacturer's specification sheet, this paper has a basis weight of 35 g/m$^2$ (DIN EN ISO 536) and an air permeability of larger than 700 l/m$^2$/s (DIN EN ISO 9,237 at 2mbar). The corresponding test results are shown in columns 6 and 7 of Table I.

As can be seen in column 1 of Table I, without any additional filter paper layer, after a test time of 15 minutes, the approximate number of hairs sticking out of the bag is larger than 60. Furthermore, in the case of using standard filter paper or VE 45 MU paper, the number of hairs is significantly reduced when providing the filter paper layer at the outside of the bag compared to a filter paper layer at the inside of the bag. In the case of the VACFILT 35/7 MB paper, even after 240 minutes test time, no hairs are sticking out of the bag independent of whether the filter paper layer is provided at the inside or at the outside of the bag.

Fig. 2A is a front view of a vacuum cleaner bag 7 in accordance with the present invention. The shape of the bag shown corresponds to the shape of the tested CAPAFIL 50 bag. In this figure, the front portion 8 of the filter medium is shown which is provided with an air inlet 9. Front and back portions of the filter medium are seamed together at an outer edge 10.

Fig. 2B shows the cross-section of the bag of Fig. 2A during operation. Air (indicated by arrows) enters the bag through air inlet 9. The front and the back portions of the filter medium are curved due to the air pressure. In this figure, a filter paper layer 12 is provided at the outer surface of the back portion (outside). Al-

ternatively, this filter paper layer can be provided inside the bag or within the filter medium (at interfaces between adjacent layers).

A quadratic filter paper layer 6 is provided. In Fig. 2B, the filter paper layer 6 is bonded to the filter medium at such a position that air entering the entrance 8 strikes the filter layer composite at the region where the filter paper layer is provided, this providing an improved retention of elongated particles being entrained with the airflow.

It is to be pointed out that the figures do not represent the dimensions correctly. Furthermore, it is to be understood that these examples serve only for illustration and are not intended as restriction. In particular, any filter layer composite can be used for the present invention. Furthermore, the vacuum cleaner bag is not restricted to a specific geometry but can have different shapes.

TABLE I

| | without filter paper layer | Standard inside | Standard outside | VE 45 MU inside | VE 45 MU outside | VACFILT 35/7 inside | VACFILT 35/7 outside |
|---|---|---|---|---|---|---|---|
| Number of hairs (approx.) | >60 | >40 | 20 – 30 | >40 | 10 – 15 | 0 | 0 |
| Test time (min.) | 15 | 15 | 15 | 15 | 15 | 240 | 240 |

EPO - Munich
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04. April 2003

## Claims

1. Filter medium, in particular, for a vacuum cleaner bag, comprising a filter structure **characterized in that** a surface or an interface of the filter structure is provided with a filter paper layer having a smaller surface area than the filter structure.

2. Filter medium according to claim 1 wherein the filter paper layer is bonded to the filter structure.

3. Filter medium according to claim 2 wherein the filter paper layer is bonded using an adhesive such as a hotmelt, a cold glue, a dry-bond adhesive, and/or a thermoplastic polymer.

4. Filter medium according to claim 2 or 3 wherein the filter paper layer is bonded to the filter structure at discrete regions.

5. Filter medium according to one of the preceding claims wherein the filter structure comprises a nonwoven layer.

6. Filter medium according to one of the preceding claims wherein the filter structure comprises successively a spunbond, an air-laid, a spunbond, a meltblown, and a spunbond layer.

7. Filter medium according to one of the preceding claims wherein the filter paper layer has an air permeability of at least about 250 $l/m^2/s$, preferably of at least about 500 $l/m^2/s$, most preferred of at least about 600 $l/m^2/s$.

8. Vacuum cleaner bag comprising a filter medium according to one of the preceding claims.

9. Vacuum cleaner bag according to claim 8 wherein the filter paper layer is provided at a region of a surface of the filter structure such that, in operation, the region is exposed directly to an airflow entering the bag.

10. Vacuum cleaner bag according to claim 8 or 9 comprising two portions of filter medium wherein both portions are bonded together at an outer edge and wherein the first portion comprises an air inlet and the second portion comprises the filter paper layer at a region opposite to the air inlet.

11. Vacuum cleaner bag according to claim 10 wherein the filter paper layer is provided at the inner surface or the outer surface of the bag.

**Abstract**

The invention is directed to a filter medium, in particular, for a vacuum cleaner bag, comprising a filter structure wherein a surface of the filter structure is provided with a filter paper layer having a smaller surface area than the filter structure.

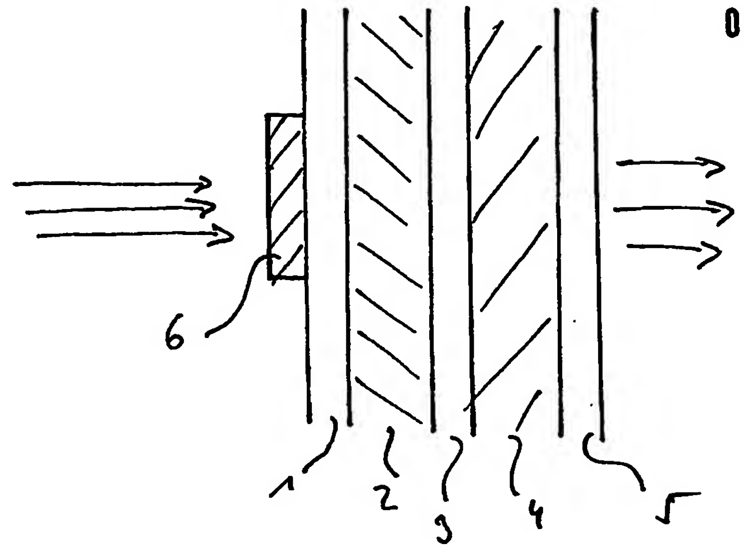


Fig. 1A

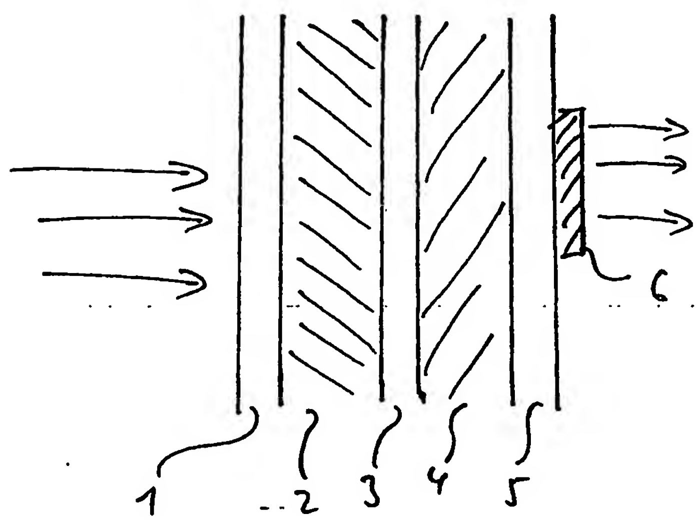


Fig. 1B

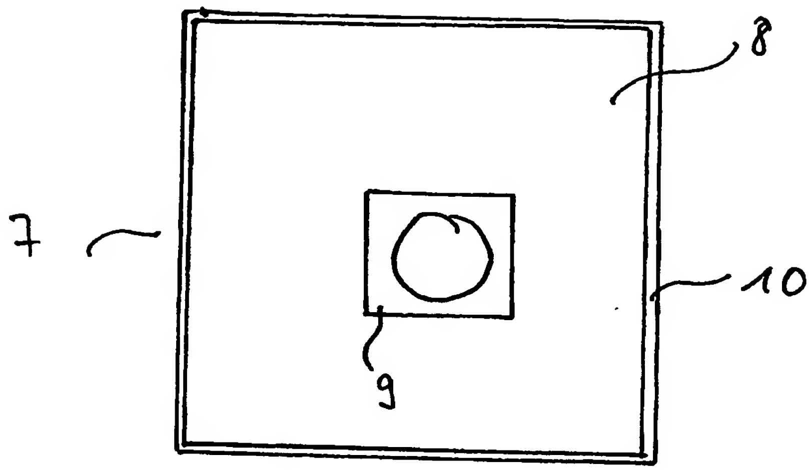


Fig. 2A

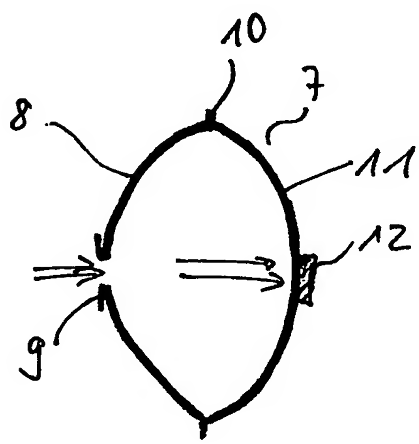


Fig. 2B

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